CLAIMS

It is claimed:

1. Apparatus for use in detecting a selected material in a sample, comprising

(a) a data storage device for storing, for each of one or more preselected materials including the selected material, a data set containing low-frequency spectral components that are (i) in a selected frequency range between DC to 50 kHz, and (ii) characteristic of that material,

(b) a detector assembly including a detector coil for generating a time-domain signal having signal components related to low-frequency electromagnetic radiation produced by the selected material in the sample, when the sample is placed adjacent the coil,

(c) signal conditioning components for converting the signal from the detector coil to an amplified conditioned signal from which frequency components above a selected frequency have been removed,

(d) an electronic computer operably connected to thethe conditioning components to receive the conditioned signal therefrom, and for processing this signal by:

(i) retrieving from thethe data storage device (a), a data set of low-frequency spectral components characteristic of the selected sample material,

(ii) filtering the conditioned signal, with such in digitized form, to selectively pass low-frequency spectral components corresponding to those of the retrieved data set;

(iii) cross-correlating the filtered signal from (ii) with the data set of low-frequency spectral components from (i) to produce a frequency-domain spectrum in a frequency range within DC to 50KHz, and

(iv) determining whether the frequency-domain spectrum contains one or more low-frequency signal components that are characteristic of the

selected material, and diagnostic of the presence or absence of such material in the sample, and

(e) an interface device operably connected to the computer for displaying the output of the processing.

2. The apparatus of claim 1, for use in detecting a material in a fluid sample, wherein the assembly includes a sample tube having sample inlet and outlet ports through which sample can be directed through the tube, and the detector coil is wound about the tube in a winding direction substantially perpendicular to the direction of sample flow in the tube.

3. The apparatus of claim 2, wherein the tube is formed of pyrex glass.

4. The apparatus of claim 2, wherein the detector assembly further includes a toroidal ferrite core having the collector tube disposed about at least a portion of the circumference of the core, and the detector coil is wound around the tube and core in a radial winding direction.

5. The apparatus of claim 4, wherein the detector assembly further includes a source of Gaussian noise and a noise-injection coil wound about the circumference of the toroidal core, through which Gaussian noise can be introduced from the source into the sample in the tube.

6. The apparatus of claim 1, wherein the detector coil includes a Helmholz coil having a pair of opposed coil elements between which the sample can be placed.

7. The apparatus of claim 6, wherein the opposed coil elements define an open sample-detection region therebetween, through which self-supporting samples can be inserted and removed.

8. The apparatus of claim 1, wherein the detection coil includes a Tesla coil.

9. The apparatus of claim 1, for use in detecting gaseous or particulate material in a gaseous-stream sample, wherein the assembly includes a collector filter effective to trap such material, as the sample passes through the filter, and the a detector coil placed against the filter and having a winding direction substantially parallel to the filter.

10. The apparatus of claim 1, wherein the computer is operable, in carrying out (iv), of identifying the frequencies of low-frequency signal components in the spectrum whose cross-spectral correlations have a selected statistical measure above background spectral noise.

11. The apparatus of claim 1, wherein the computer is operable, in carrying out (iv), of (iva) receiving an additional frequency-domain spectrum for a given sample, (ivb) adding the additional spectrum to the originally produced spectrum, and averaging the added spectra, and (ivc) repeating (iva) and (ivb) until components in the summed and averaged spectrum have a selected statistical measure above background noise.

12. A method for detecting a selected material in a sample, comprising:

(a) placing the sample adjacent a detector coil, thereby to generate an electromagnetic time-domain signal composed of sample source radiation,

(b) conditioning the time-domain signal to convert the signal to an amplified conditioned signal from which frequency components above a selected frequency have been removed,

(c) filtering the conditioned time-domain signal to selectively pass low-frequency spectral components that are (i) in a frequency range between DC and 50kHz, and (ii) characteristic of the selected material,

(d) cross-correlating the filtered signal from (c) with a data set of low-frequency spectral components that are (i) in a frequency range between DC and

50kHz, and (ii) characteristic of a selected material, to produce a frequency-domain spectrum in the frequency range within DC to 50KHz, and

(e) determining whether the frequency-domain spectrum contains one or more low-frequency signal components that are characteristic of the selected material, and diagnostic of the presence or absence of such material in the sample.

13. The method of claim 12, for use in detecting a material in a fluid sample, wherein the placing includes flowing the sample through a sample tube having sample inlet and outlet ports, and the detector coil is wound about the tube in a winding direction substantially perpendicular to the direction of sample flow in the tube.

14. The method of claim 13, wherein the sample tube is disposed adjacent a toroidal ferrite core, the detector coil is wound around the tube and core in a radial winding direction, and which further includes injecting Gaussian noise into the sample during generation of the time-domain signal.

15. The method of claim 12, wherein the detector coil includes a Helmholz coil having a pair of opposed coil elements, and the placing includes placing the sample between the coil elements.

16. The method of claim 12, for use in detecting gaseous or particulate material in a gaseous-stream sample, wherein the placing includes passing the sample through a planar filter effective to trap such material, as the sample passes through the filter, and the detector coil has a winding direction substantially parallel to the plane of the filter.

17. The method of claim 12, wherein the determining includes identifying the frequencies of low-frequency signal components in the spectrum whose cross-spectral correlations have a selected statistical measure above background spectral noise.

18. The method of claim 12, wherein the determining includes (a) receiving an additional frequency-domain spectrum for a given sample, (b) adding the additional spectrum to the originally produced spectrum, and averaging the added spectra, and (c) repeating (a) and (b) until components in the summed and averaged spectrum have a selected statistical measure above background noise.

19. A system for detecting a selected material in a sample, comprising:

means for placing the sample adjacent a detector coil, thereby to generate an electromagnetic time-domain signal composed of sample source radiation,

means for conditioning the time-domain signal to convert the signal to an amplified conditioned signal from which frequency components above a selected frequency have been removed,

means for filtering the conditioned time-domain signal to selectively pass low-frequency spectral components that are (i) in a frequency range between DC and 50kHz, and (ii) characteristic of the selected material,

means for cross-correlating the filtered signal with a data set of low-frequency spectral components that are (i) in a frequency range between DC and 50kHz, and (ii) characteristic of a selected material, to produce a frequency-domain spectrum in the frequency range within DC to 50KHz, and

means for determining whether the frequency-domain spectrum contains one or more low-frequency signal components that are characteristic of the selected material, and diagnostic of the presence or absence of such material in the sample.

20. The system of claim 19, further comprising means for automatically extracting the sample from an environment surrounding the system, and wherein the sample is air or gas.

21. The system of claim 19 wherein the means for placing includes toroidal detector means for detecting an electromagnetic signal from the sample.